Syllabus MATH F614 Fall 2025

Essential Information

Course Title	Numerical Linear Algebra
Instructor	Ed Bueler `elbueler@alaska.edu`
Class meeting	MWF 2:15–3:15 pm, Chapman 107
CRNs	in-person 901: 75364 online 701: 75371 (lecture zoom link on Canvas)
Public website	`bueler.github.io/nla`
Canvas website	`canvas.alaska.edu/courses/27130`
Required text	L. N. Trefethen and D. Bau, *Numerical Linear Algebra*, SIAM Press 1997

Description

This course covers how matrices and vectors are actually handled in a fast and accurate manner on computers. This is essential technology for scientific and engineering computation, and even for understanding the modern world. Applications include large linear systems, least squares methods, systems of ordinary differential equations, inverse methods in geophysics, and Markov processes. Numerical linear algebra is equally important for partial differential equations, network problems, and optimization, and it is an underlying theory in machine learning.

The geometry of the matrix action is the central idea, set in a clear mathematical framework. We will cover famous matrix decompositions and algorithms: singular value decomposition (SVD), Householder reflections and the QR decomposition, LU and Cholesky decompositions, spectral theorem, Schur decomposition, the QR method for eigenvalues, and Krylov methods. The conditioning of problems and the stability of floating-point algorithms are central themes.

Student competence with a scientific computing language is a course goal, so homework assignments will require actual implementations. Examples/demonstrations in class, and also homework solutions, will routinely use Matlab/Octave, but student work can also be done in Python or Julia. (All of these are well-suited to numerical linear algebra; see the separate *Programming languages compared* PDF.) The instructor and the textbook support Matlab/Octave, including help with getting started. If you have never used a programming language before then please show initiative in learning this aspect of the course; it is a good course in which to learn it!

Course Goals and Student Learning Outcomes

At the end you will be able to understand and apply the ideas and algorithms of numerical linear algebra. You will be very comfortable with a scientific computing language.

Prerequisites

Officially: *MATH 314 Linear Algebra or equivalent. Recommended: MATH 421 Applied Analysis OR MATH 401 Introduction to Real Analysis OR equivalent post-calculus course in analysis.*

In summary, the prerequisites are undergraduate linear algebra, exposure to or interest in scientific programming, and a certain amount of mathematical maturity.

The Hybrid Classroom

There are two sections of the class, in-person (901) and online (701). They are treated as one course and occur simultaneously. In this "hybrid" set-up, each lecture will be a recorded Zoom session generated from Chapman 107. (The link for the Zoom session is in Canvas. The recordings will be linked from inside Canvas only; they are not public.) I will try to treat all students the same regarding proctored assessments—see below—and participation during class time. Students have certain obligations to help make this work:

- **in-person students**: To allow in-class play with Matlab etc., and to help classroom communication for e.g. group work, please bring a laptop if you can, and perhaps join the Zoom session so you can see the online students. I prefer that in-person students turn in their homework assignments on paper.
- **online students**: Please sign into the Zoom session, from Canvas, just before class starts. Please participate as energetically as you can, and, if possible, keep your camera on. Regarding in-class group work, check for worksheet PDFs on the Daily Log tab of the public site before class starts. When you turn in homework assignments electronically, please generate a clear, well-ordered, and combined PDF. You will need to schedule proctoring for the in-class assessments (see below), or attend in-person on those days.

Schedule and Online Materials

The public course website includes a day-by-day schedule listing the textbook sections to be covered, the due date of each homework Assignment, and timing of the Midterm Quizzes and Final Exam. Please consult this schedule frequently. It is subject to change, but it will be kept up to date.

Most course materials (syllabus, schedule, homework Assignments, code examples, etc.) will be posted on the public website. Some private-access course materials (student grades, homework and exam solutions) will go on the Canvas site.

Office Hours and Communication

My Office Hours are shown online at `bueler.github.io/OffHrs.htm`; I hold office hours in Chapman 306C. Students can also schedule meetings with me outside of regular office hours; please send an email. I will use Canvas to send announcements. If I need to contact you outside of class times, I'll try to email via Canvas. (Please set your email address in Canvas to one that you check regularly!)

Evaluation and Grades

Homework	nearly weekly	50%
Midterm Quiz 1	in-class Wednesday 8 October	15%
Midterm Quiz 2	in-class Wednesday 12 November	15%
Final Exam	in-class Thursday 11 December 1-3 pm	20%
total		100%

The scores of the various parts will be summed and the final course grade will be assigned as follows:

A	93–100%	B-	79–81%	D+	65–67%
A-	90–92%	C+	76–78%	D	60–64%
B+	87–89%	C	68–75%	D-	57–59%
B	82–86%	C-	not given	F	$\le 56\%$

These ranges are a guarantee and a lower bound. I reserve the right to increase your grade above these ranges based on the actual difficulty of the work and/or on average class performance. Any such increases will preserve grade ordering by weighted total score.

Homework

Homework is due at the start of class. **Late homework is not accepted.** If you have unavoidable circumstances which do not allow you to turn in an Assignment on time then please contact me (`elbueler@alaska.edu`) in advance.

Assignments and their due dates will regularly be posted at the `public website`. The homework consists of by-hand computations, design and analysis of numerical algorithms, computer implementation of those algorithms, by-hand and computer visualization, rigorously-justified examples and counter-examples, and proofs. Problems very similar to, or shortened versions of, Homework problems will appear on the in-class Midterm Quizzes.

Exercises on the homework will require Matlab, or another suitable scientific computing language, both as a super-calculator and for writing programs. Codes on homework solutions will only be in Matlab/Octave. The public website will also link a growing list of short Matlab/Octave codes; this is a good resource for examples.

You may talk to other students about the Homework, and you may use internet and generative AI resources in your solutions. However, note that actual comprehension of the ideas on the Homework is required to get even a passing grade in the course, and this is because the in-class, on paper assessments (Quizzes and the Final Exam) will allow no technology whatsoever. These assessments will have a large overlap with Homework content; questions from Homework will be duplicated on to the assessments.

Exams

There will be two in-class, hour-long Midterm Quizzes covering mostly basic concepts and definitions.

The in-class Final Exam will require you to be familiar with **three** of the major methods we have studied. I will describe the format of this Exam in more detail later.

Make-up Quizzes or Final Exam will be given only for documented extenuating circumstances, at my discretion. Department policy (below) does not allow me to move the time of the Final Exam.

Rules and Policies

Incomplete Grade

Incomplete (I) will only be given in DMS courses in cases where the student has completed the majority (normally all but the last three weeks) of a course with a grade of C or better, but for personal reasons beyond his/her control has been unable to complete the course during the regular term. Negligence or indifference are not acceptable reasons for granting an incomplete grade.

Late Withdrawals

A withdrawal after the deadline from a DMS course will normally be granted only in cases where the student is performing satisfactorily (i.e., C or better) in a course, but has exceptional reasons, beyond his/her control, for being unable to complete the course. These exceptional reasons should be detailed in writing to the instructor, Department Chair and the Dean.

No Early Final Examinations

Final examinations for DMS courses shall not be held earlier than the date and time published in the official term schedule. Normally, a student will not be allowed to take a final exam early. Exceptions can be made by individual instructors, but should only be allowed in exceptional circumstances and in a manner which doesn't endanger the security of the exam.

Academic Dishonesty

Academic dishonesty, including cheating and plagiarism, will not be tolerated. It is a violation of the Student Code of Conduct and will be punished according to UAF procedures.

Student protections and service statement

Every qualified student is welcome in my classroom. As needed, I am happy to work with you, Disability Services, Veterans' Services, Rural Student Services, and so on, to find reasonable accommodations. Students at this University are protected against sexual harassment and discrimination (Title IX), and minors have additional protections. For more information on your rights as a student and the resources available to you to resolve problems, please go the following site: www.uaf.edu/handbook.

[syllabus version: August 8, 2025]